

## Development of Kinetic Tiles

Vidhi Pandey<sup>1</sup>, Brijveer Singh Saini<sup>1</sup>, Sunny Gour<sup>1</sup>, Ratendra Singh<sup>1</sup>, Mohammad Shahid<sup>1</sup>

<sup>1</sup>Electrical Engineering Department, Galgotias College of Engineering and Technology, Greater Noida 201306

**Abstract**— Human have mobility characteristics due to which they move into surroundings by applying force on the surface, which is been of no use. As no one often think of using this energy to generate electricity by the tremendous amount of force wasted worldwide in walking. The amalgamation of piezo electric technology with normal ceramic tiles in a very specific configuration is the beauty of this project. The paper proposes a configuration for the development of kinetic tiles that can be used as ordinary floor tile in future.

The proposed idea of generating electricity with the pressure of foot or any kind of force exertion using piezoelectric crystal is an innovation to the society. This paper presents an idea of prototype of piezoelectric based energy harvester for generating electricity from the floor tile developed during student's project.

**Keyword**— Piezoelectric, Tile, Power generation, Renewable Energy, etc.

### I. INTRODUCTION

In India, due to high population, the chances of energy generation are very high specially in overcrowded places like railway station, metro stations, bus stands, temples and shopping complexes etc. With the increase in population the requirement of power is increasing tremendously. In conventional power plants, the need of fuel and trained man power are the biggest challenges. With the development in country, the fuel price and employee incomes are also increasing. High installation and maintenance cost of generators, boilers, crushers etc. also contribute to the cost of generation. The fuel used in conventional power plants is also nonrenewable, that is ending very quickly.

"Renewable" assets of vitality, for instance, photovoltaic cell Panel, Wind Energy can likewise be utilized to gather power. However, these sources are constrained to a specific region for example the solar energy is often utilized just at the spot where the sun focus is entirely great and continuous. Apart from all their human movements like nonstop driving of the hand wrenches and tiny generators are often additionally used to deliver power however of those

wonder of manufacturing power requires a uniform human exertion and checking.

Today, due to incrementation in demand the asset that is nonrenewable energy is being consumed at a rapid pace. In this manner there's a requirement to locate a substitute technique for the generation of power separated from these strategies with the goal that it is often made effortlessly accessible to even the weaker segment and needy individuals of the general public.

So, this technique uses piezoelectric plates which create Voltage by experiencing any kind of force or pressure on it. That is mechanical force get converted into electrical power which is utilized to charge battery and to use the stored energy further [3].

### II. PIEZOELECTRIC MATERIAL

Piezo is a Greek term which means to press. Piezo materials have ability to convert mechanical stress into voltage as output. The phenomenon for piezoelectric material is to convert mechanical/structural vibration into electrical outputs. When pressure is applied the piezo plate's experiences imbalance between the two surfaces where the two ends become polarized. There generators can produce relatively high voltage output but low electrical currents.

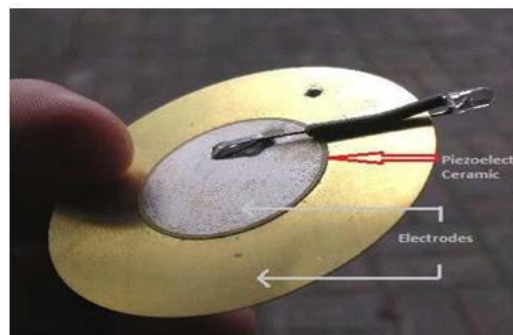


Fig. 1. Piezo Electric Transducer

### III. HARDWARE IMPLEMENTATION

The piezoelectric material is placed in an array formation between two wood plates which look like a tile of 12mm. A 4mm sheet made up of form is placed on the developed tile structure for the safety of circuit and connections [1]. Total twenty-nine

piezoelectric transducer are connected in series and parallel combination. Rubber support is provided to avoid sudden pressure on the tile. The tile is of 1\*1 meter in size[8]. The connections to voltaic battery, inverter and capacitor are provided under the fiber sheet. The voltage generated across an kinetic tile is stored to a voltaic battery to be used in the dark.

#### IV. WORKING PRINCIPLE

When the foot is placed on the tile the mechanical energy of the foot step is transferred to the piezo material. The piezo transducer in piezo electric material experiences the force and converts energy from foot step to electrical energy which would be small in amount which is 10-12 volts. Due to which dc-dc booster is used to step up the voltage and then inverter will supply electrical energy to the required loads [4].

Fig. 2. Schematic representation of working model

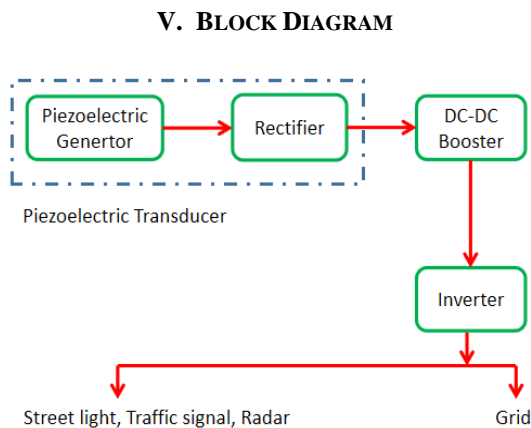


Fig. 3. Block diagram of project

#### VI. HARDWARE TESTING

The testing is required to check the output of the system. By changing the weights, different output is obtained. So it's mandatory to check the behavior of the system at different weights. Check the effect of the output voltage and current by series parallel

combination. By changing the series parallel connection, different output power is obtained. The vibrational energy converted into electrical energy by this device.

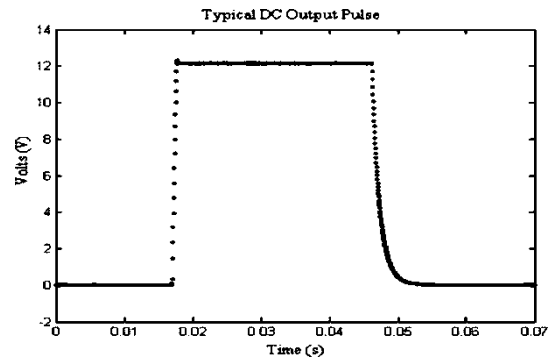


Fig. 4. Typical Output of DC pulse

#### A. Testing of weight on the piezoelectric tile

This test is performed to check the output power of tiles with applying various weights. Various weights are applied on tile to get different outputs. The weights applied on the tile is 1/4<sup>th</sup> of full pressure, 1/2 of full pressure, 3/4<sup>th</sup> of full pressure, and different power of the piezoelectric tile are observed. The graph below in figure 5 shows the different output power with different weights [7]. The full pressure that is 100% of the pressure that the system can work upon is avoided because it can potentially harm the device or can completely damage the device.

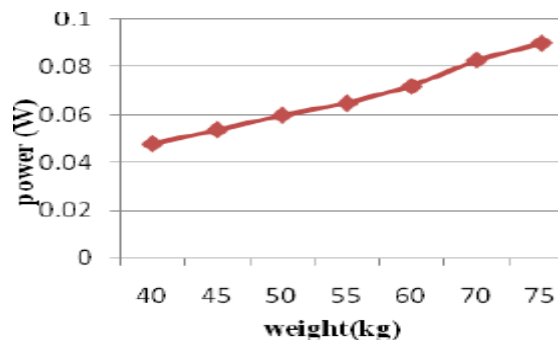


Fig. 5. Weight v/s Power Graph

#### B. Output testing by the different connection

The output of one piezoelectric material is very less but if few piezoelectric materials are combined in series or parallel then the output is increased. By connecting some PZT with series or parallel different results are observed. When we 29 PZT are connected in series, good output voltage is obtained but there is poor output current where else in parallel combination, good output current is obtained but there is poor voltage. To remove this problem, 15 and 14 PZT are combined in series and parallel connection. The graph above in figure 5 shows the

output voltage and current. The output of voltage and current is gradually increased when the PZT is connected with series parallel combination.

By this combination the current is gradually increased with the output voltage. To get the continuous output from piezoelectric tile a capacitor is connected between the tile and load. The capacitor is periodically discharged through DC-DC converter in order to make a possible output of 12V DC pulse [5]. The output of piezoelectric tile is rectifying to charge the capacitor. By this combination 0.0925W output power is obtained.

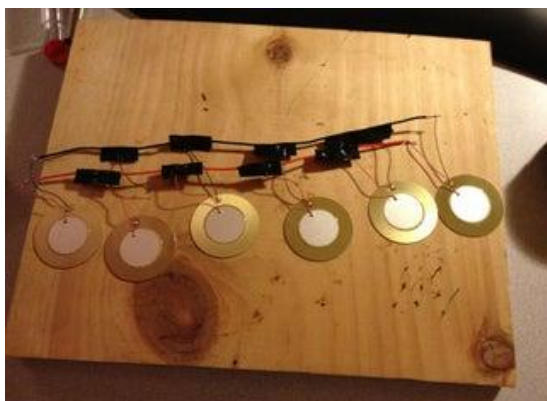


Fig. 6. PZT in Series & Parallel connections

### C. PZT layout

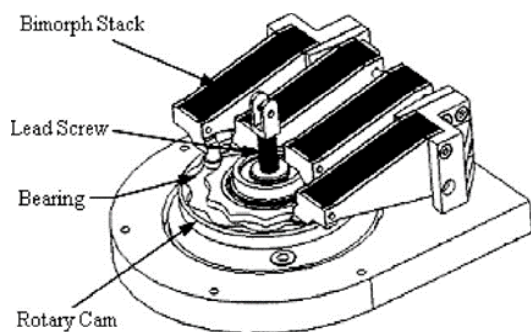


Fig. 7. Hardware of PZT tiles generator

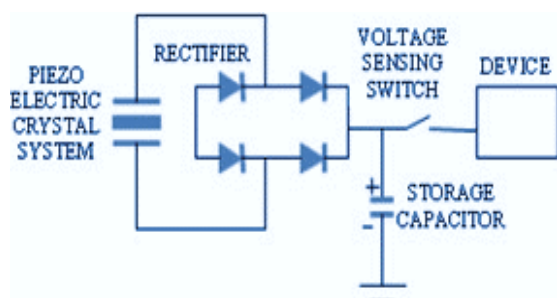


Fig. 8. Circuit diagram of PZT using AC-DC converter

### VII. ANALYSIS

On performing a steeple analysis of the project, consisting of 6 factors that are: Societal, Technological, Ethical, Political, Legal & Economic measures, a statement can be drawn that-

- **Societal-** With the rapidly increasing population, the energy demands are also increasing day by day. So, collecting the energy from the locomotions of a human being would be adaptable to such societal needs.
- **Ethical-** Since it is a natural source for energy storing, it does not cause any harm to the nature.
- **Political-** Since the current usage rates of energy are too high, they may lead to insufficient energy sources for future generations. Thus, gathering energy from locomotions of human beings would ensure to fulfil the present & future electricity demands.
- **Legal-** Piezo tiles won't cause any harm neither to humans nor to nature, thus it could be useful to everyone.
- **Technology-** The implementation of piezo tiles in the areas would surely lead to advancements in technologies of that country [6].
- **Economical-** Since the energy is generated via human locomotion, this phenomenon is very cost friendly & moreover makes very important savings of electricity for later usage [2].

The human body is always in motion (either walking or running). These 2 activities provide a lot of energy for use. When a human steps into a piezo tile, kinetic energy is generated and transferred to the piezo sensing materials. It results in the production of a very low voltage DC current, which is stored in a battery connected in the system. For using the DC charge for powering AC devices, an inverter is further placed in the system to convert DC supply into AC.

Since, the pressure and power generated are proportional to each other, i.e.

$$P \propto Wt.$$

(1)

$$\text{Or } P = K.Wt \text{ ( K = Proportionality Constant )}$$

(2)

For instance, the tiles and no. of piezo plates used in this project are able to produce 12 V of Voltage and 0.0077 A of current, when a weight of 75 kilograms is placed over it. Thus,

**Power generated (V\*I) = 12 \* 0.0077 = 0.0925 Watt.**

(3)

By solving this, k can be determined, which could be calculated as:

$$K = P/Wt = 0.0925 / 75 \text{ i.e. } K=0.00123$$

(4)

### VIII. ADVANTAGES

- Power is simply generated by applying force on it, which counts in example like walking on it.
- Mechanical force is converted into electrical energy hence fuel input in such a system is zero.
- Uses inexhaustible source of energy from nature hence it is a Non-conventional system.
- It has non-movable elements, hence the system has long service life.
- Power generated in a piezo electric tile is self-generating and therefore no external power is required.
- This system occupies very less space and hence is very compact.
- Sensors do have very high sensitivity.
- System requires less maintenance hence it is very reliable.
- No need to provide any type of external fuel and power supply hence it is very economical.
- In the process of electricity generation system releases neither any residue nor pollutant hence it is eco-friendly.
- Generated power is stored in batteries i.e., easily portable.

### IX. APPLICATIONS

- Power generated by Kinetic electric tile can be used in various fields such as agriculture sector, domestic applications, traffic-lighting.
- Kinetic electric tile can supply electrical energy to both D.C & A.C devices.
- Electricity generated through this procedure and methodology can also be implemented in various crowded places.
- Kinetic electric tile generated power can also be used in faulty conditions, and to compensate the grid supply .
- Stairs, railway stations, domestic applications, dance floor etc.

- Metal fault detection, LPG stove lighter, pressure sensor.

### X. ACKNOWLEDGEMENT

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### XI. CONCLUSION

Due to the rapid growth of population, electricity demands are also spiking. Every technology nowadays is extracting energy mainly from the natural sources. But, due to this next era technology of Piezo tiles, constant energy is stored in the batteries, due to the human locomotions for later uses.

This project could be easily and effectively implemented in all crowded places for better generation like- Museums, Metro stations, Airports, Markets, Railway platforms, Busy markets, Gymnasiums etc. Thus, by this project both DC as well as AC loads can be operated, by converting the generated energy from Piezo sensors in suitable form. This technology has a vast scope in fulfilling future energy demands along with a lot possible advancements and more efficient ways of operation.

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